September 1973

U S D A FOREST SERVICE
RESEARCH NOTE RM-248

FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE
ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Seventeen-Year Sediment Production from a Semiarid Watershed in the Southwest[1]

Earl F. Aldon and George Garcia[2]

Average annual rate of sediment production declined 71 percent in the period 1967-71 compared with the period 1956-66 on a 471-acre watershed on the Rio Puerco drainage in New Mexico. This decline was a result of on increase in plant size and litter production on the alluvial flood plain.

Oxford: 116.6:385.3. Keywords: Erosion control, sediment.

In spite of the recent concern with other environmental contaminants of water, sediment remains the number one contributor to water pollution (Robinson 1971, Grant 1971). Significant amounts of sediment are present in most waterways most of the time. The damaging effects on downstream values are well known. Of current interest is the attachment of heavy metals and pesticides from industrial, agricultural, and urban sources to sediment particles. We need to understand sediment deposition rates if we are to know the ultimate resting place for these pollutants. Information on the deposition rates and amounts of sediment is scarce for many areas in the Southwest. In addition, information is lacking on what management practices may favorably alter these rates.

[1]*Research reported here was conducted in cooperation with the Bureau of Land Management, U.S. Department of the Interior, Albuquerque, New Mexico.*

[2]*Principal Hydrologist and Forestry Research Technician, respectively, Rocky Mountain Forest and Range Experiment Station, located at Station's Research Work Unit at Albuquerque, in cooperation with University of New Mexico; Station's central headquarters is maintained at Fort Collins, in cooperation with Colorado State University.*

The objective of this study was to determine the long-term effects of management practices on plant changes and sediment yields from a semiarid watershed in the Rio Puerco drainage of New Mexico.

Study Site and Methods

The San Luis watersheds on the Rio Puerco drainage are located 58 miles northwest of Albuquerque, New Mexico, in the transition zone between woodland and semidesert grassland. The area is comprised of mesas or uplands, steep rocky breaks, and alluvial grasslands.

The study watershed, watershed II, encompasses 471 acres (0.74 square mile). The headwaters originate on the mesas that break off into steep, rocky slopes. These slopes give way to rolling foothills that merge with the alluvial bottoms. A layer of Mesa Verde sandstone overlies Mancos shale. The sandstone breaks and underlying shales form the parent soil material, the texture of which varies from sandy loams to silty clays. A study of the soil characteristics reveals no serious soil problems in terms of salinity or fertility (Campbell 1968).

In 1952, a reservoir with a capacity of about 13 acre-feet was constructed on the alluvium to

measure runoff and sediment. Flow is ephemeral and the reservoir dries out seasonally. In 1956 the reservoir was cleaned and a survey consisting of five cross sections was made. These cross sections were resurveyed in 1967 and 1972. The changes in volume were used as a measure of sediment. No adjustment was made for sediment that might have passed through an outlet pipe or through the spillway (at time of overflow). These amounts are considered to be only a small percentage of the total (Aldon 1964).

Pits were randomly located in the reservoir during the resurveys, and volume weight samples were taken at 0.5-foot intervals throughout the 4.5-foot depth of the pits. Brass cylinders (137.4 cc volume) were used to obtain core samples for volume weight determinations.

Volume and volume-weight measurements were converted to sediment rates in tons per acre and tons per square mile per year.

Precipitation, runoff, ground cover, and forage production measurements have been described previously (Aldon 1964, Hickey and Garcia 1964). Ground cover was measured by the 3/4-inch loop-frequency method on 25 clusters of three 100-foot transects randomly distributed over the watershed.

Management on the area throughout the study consisted of summer-deferred grazing with 55 percent utilization of alkali sacaton (Sporobolus airoides (Torr.) Torr.) (Aldon 1966). Forage production was measured each fall by the weight-estimate and double-sampling technique, and stocking rates were adjusted to achieve the utilization standard desired (Aldon and Garcia 1971).

In 1963 all areas having slopes less than 5 percent were ripped to retard surface runoff. This treatment effectively reduced runoff, but the change was short lived (Aldon 1966). Ripping caused a favorable shift in forage production from galleta (Hilaria jamesii (Torr.) Benth.) to alkali sacaton—a pattern that has persisted for 10 years (Aldon and Garcia 1972).

Results

The average annual rate of sediment production declined 71 percent in the period 1967-71 compared with the period 1956-66, even though averages of runoff and precipitation from 1967 to 1972 were about the same or slightly higher than in the period of higher sediment production (table 1).

Table 1.--Precipitation, runoff, perennial grass production, loop frequency hits, and sediment production from San Luis watershed 11, 1956-72

Year	Precipitation		Surface runoff	Grass production (air-dry)	Loop frequency hits				Sediment		
	Annual (Nov. 1-Oct. 31)	Growing season (May 1-Nov. 1)			Perennial grass	Rock	Litter	Bare soil	Cumulative volume in reservoir	Average annual rate	
	Inches		*Acre-ft*	*Lbs/acre*	*Number*				Ft^3	$Tons/m^2/yr$	*Tons/acre/yr*
1956	6.21	2.20	10.04	73.3					0	0	0
1957	12.05	8.16	88.62	103.0							
1958	12.72	6.44	17.20	237.8	3.08	6.02	5.33	77.93			
1959	10.72	6.84	24.28	195.4							
1960	11.48	5.42	14.19	167.4							
1961	10.60	9.59	44.83	250.0	8.43	8.50	14.65	63.72			
1962	6.25	2.32	2.92	332.0							
1963	9.42	3.94	0.00	282.9							
1964	9.00	6.57	18.28	497.7	10.03	10.49	7.01	71.01			
1965	12.81	9.02	0.00	429.4							
1966	8.62	6.05	4.67	525.0							
1967	10.33	9.08	38.13	522.3					112,184	493	.77
1968	10.11	5.60	.13	561.8							
1969	14.84	11.57	39.44	721.0	9.51	13.63	16.72	58.74			
1970	8.50	5.92	3.94	653.0							
1971	10.03	7.14	27.25	509.0	9.69	13.47	17.22	58.93			
1972									17,758	141	.22
Average											
1956-66	9.99	6.05	20.46								
1967-71	10.76	7.86	21.78								

Sediment declined as a result of increased plant size and litter production on the alluvial flood plain above the reservoir (fig. 1). As sediment-laden flash floodwaters hit the alluvial fan, they were slowed down by plants and litter long enough to allow sediment to settle out above the reservoir.

The increase in plants is reflected in two ways. Perennial grass production has steadily increased from 73 pounds per acre in 1956 to a high of 721 pounds in 1969. Annual grass production varies with precipitation, but the steady yearly increase is obvious. These production figures suggest that individual perennial plants are increasing in size. Secondly, ground-cover data show a decrease in bare-soil hits from 78 to 58 and an increase in litter from 5 to 17. Perennial grass hits went from a low of 3 to a high of 10 hits. Francis et al. (1972) note that loop frequency estimates presence or absence of plants and shows a bias in favor of plants and underrates soil surface factors (litter and bare soil). The doubling of hits on grass and litter and the reduction on bare soil between 1956 and 1972 may indicate increases in the number of plants. The sediment reduction can be attributed to reduction in floodwater velocities by increases in plant size, and possibly an increase in plant numbers, and the resultant increase in litter production.

Figure 1.--
The alluvial floodplain:

In 1956, plants were scarce and sediment was abundant;

In 1969, conditions were reversed.

Literature Cited

Aldon, Earl F.
1964. Ground-cover changes in relation to runoff and erosion in west-central New Mexico. U.S. For. Serv. Res. Note RM-34, 4 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Aldon, Earl F.
1966. Deferred grazing and soil ripping improves forage on New Mexico's Rio Puerco drainage. N.M. Stockman 31(11):44-46.

Aldon, Earl F., and George Garcia.
1971. Stocking rangelands on the Rio Puerco in New Mexico. J. Range Manage. 24:344-345.

Aldon, Earl F., and George Garcia.
1972. Vegetation changes as a result of soil ripping on the Rio Puerco in New Mexico. J. Range Manage. 25:381-383.

Campbell, R. E.
1968. Production capabilities of some upper Rio Puerco soils of New Mexico. U.S. For. Serv. Res. Note RM-108, 7 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Francis, Richard E., Richard S. Driscoll, and Jack N. Reppert.
1972. Loop-frequency as related to plant cover, herbage production, and plant density. USDA For. Serv. Res. Pap. RM-94, 8 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Grant, K. E.
1971. Sediment: Everybody's pollution problem. p. 23-28. **In** 33d Nat. Farm Ins. Chamber of Commerce Proc., Des Moines, Iowa.

Hickey, Wayne C., Jr., and George Garcia.
1964. Changes in perennial grass cover following conversions from yearlong to summer-deferred grazing in west-central New Mexico. U.S. For. Serv. Res. Note RM-33, 3 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Robinson, A. R.
1971. A primer on agricultural pollution: Sediment. J. Soil Water Conserv. 26:61-62.